Herring Control Rule Advice

Andrew Applegate
NEFMC Staff

EBFM PDT Chair

EBFM Committee
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New England Fishery Management Council

Schedule
Herring ABC control rule advice

Date	Committee	Action
April 14	EBFM PDT	Presentations of analyses and draft material
May 5	EBFM PDT	Final sections and conclusions
May 20	SSC	Provides input to the Council
June 2	EBFM & Herring Committee	Receives PDT and SSC reports; reviews Amendment 8 scoping comments
June 16-18	Council	Receives PDT and SSC reports; EBFM & Herring Committee reports

Draft Advice Outline

- Problem statement and objectives
  - What is Amendment 8 meant to do?
- Management background
  - Current management
  - Forage availability
- Examples of forage species management elsewhere
  - Why?
  - Different approaches

Draft Advice Outline

- Performance of types of control rules
  - Average stock size relative to B_{msy}
  - Changes in average yield
  - Stock stability
  - Probability of reducing catch to zero
- Herring consumption estimates
  - Total consumption
  - Percent of herring in diet

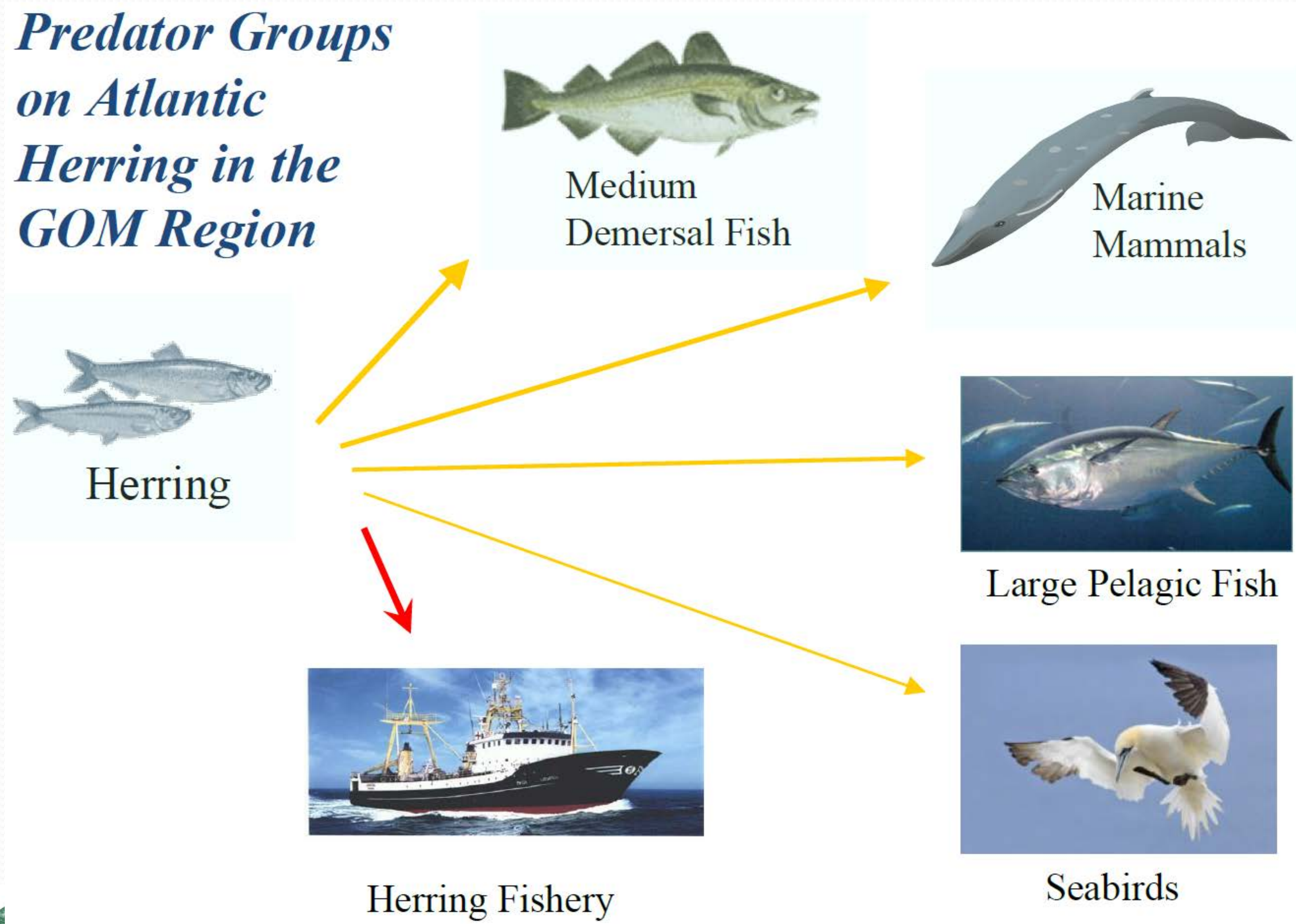
Draft Advice Outline

- Ecological implications
  - Predators and alternative prey sources
  - Effects on predator productivity
- Economic implications
  - Potential benefits vs revenue loss
  - Potential for localized and community effects

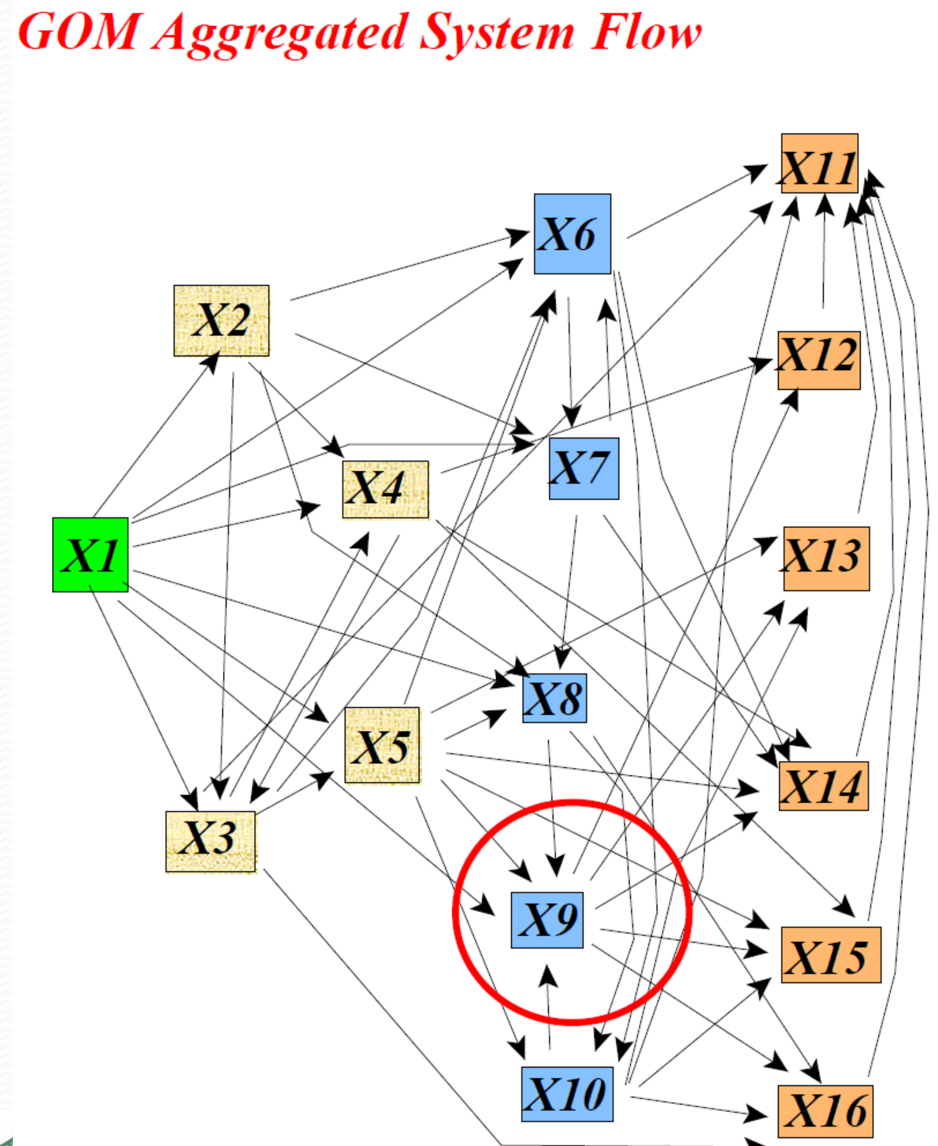
Draft Advice Outline

- Effects of climate change on prey availability
  - Match/mismatch
  - Other effects
- Conclusions and recommendations
  - Options to consider
  - Characteristics and probable results

Simple


Predator Groups on Atlantic Herring in the GOM Region
Herring
Medium Demersal Fish
Marine Mammals
Large Pelagic Fish
Seabirds
Herring Fishery

Yet Complex



X1 Phytoplankton
X2 Bacteria
X3 Zooplankton
X4 Gelatineous zoop
X5 Micronecktton
X6 Macro-benthos
X7 Mega-benthos
X8 Shrimp
X9 Pelagic fish
X10 Demerdal fish
X11 Sharks
X12 HMS
X13 Pinnipeds
X14 Baleen whales
X15 Toothed whales
X16 Seabirds

Forage management examples in the literature

- MAFMC white paper synthesizes regional forage fish management
- Historical perspective on forage fish management (Rice and Duplisea (2014)
- Traditional MSY approach may not work when
  - Predators have high connectedness to prey or
  - Prey usually has a relatively high biomass within the ecosystem
- Development of tools to evaluate economic tradeoffs
  - Inclusion of economic analysis in ecosystem modeling

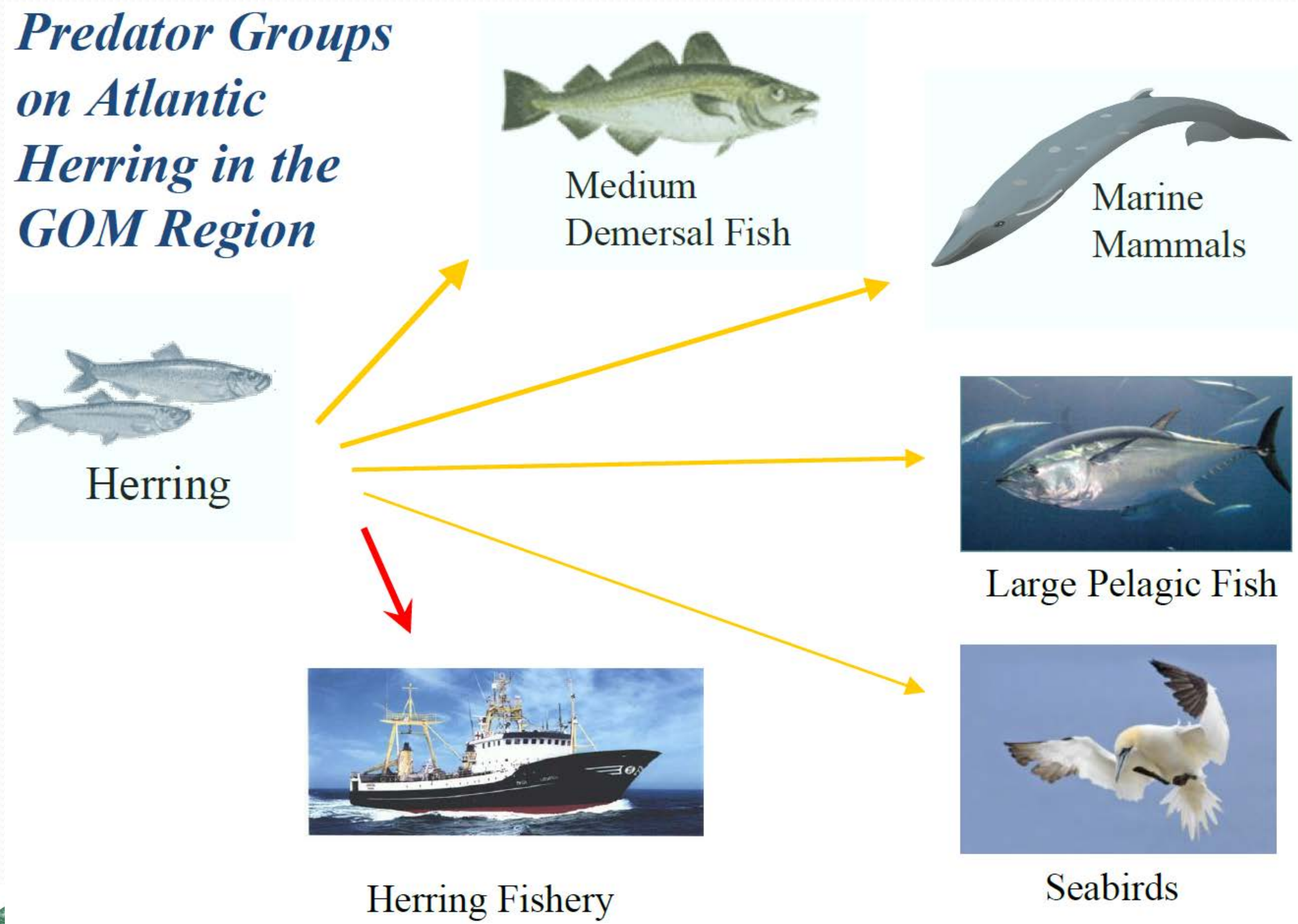
Forage management examples in the literature

- Other ecosystem issues or concerns
  - Predator-prey interactions occur on spatial scales smaller than stock-wide or regional
  - Alternative prey are not necessarily equal – nutritional content and hunting difficulty

Forage management examples in the literature

- Economic literature is sparse
- Lobster fishery not highly sensitive to herring landings
  - Price differential for alternative sources
  - Lehuta, Holland, & Pershing 2014
- Lobster productivity enhancement
  - Mitigated with different baits
- Fishing forage fish exacerbates natural variation and yield (Essington et al 2014)

Simple


Predator Groups on Atlantic Herring in the GOM Region
Medium Demersal Fish
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Seabirds
Herring Fishery

ABC control rule with $B=B_{msy}$ target

Beneficiaries	Mechanism	Magnitude
Herring fishing industry	Catches closer to MSY. Total revenue may be offset by supply/demand relationship	Small when population > B_{msy}
Lobster industry	Greater bait supply	Small if substitute bait sources exist
Lobster resource	Herring eaten from traps may boost lobster growth and productivity	Significant – Grabowski 2010; 80% of diet is bait in fished waters
Fish larvae	Herring are zooplankton predators, either removing foods in common or direct consumption of larvae and eggs.	Unknown
Tuna industry	Decreases in bait supply	Small if substitute bait sources exist

ABC control rule with $B > B_{msy}$ target

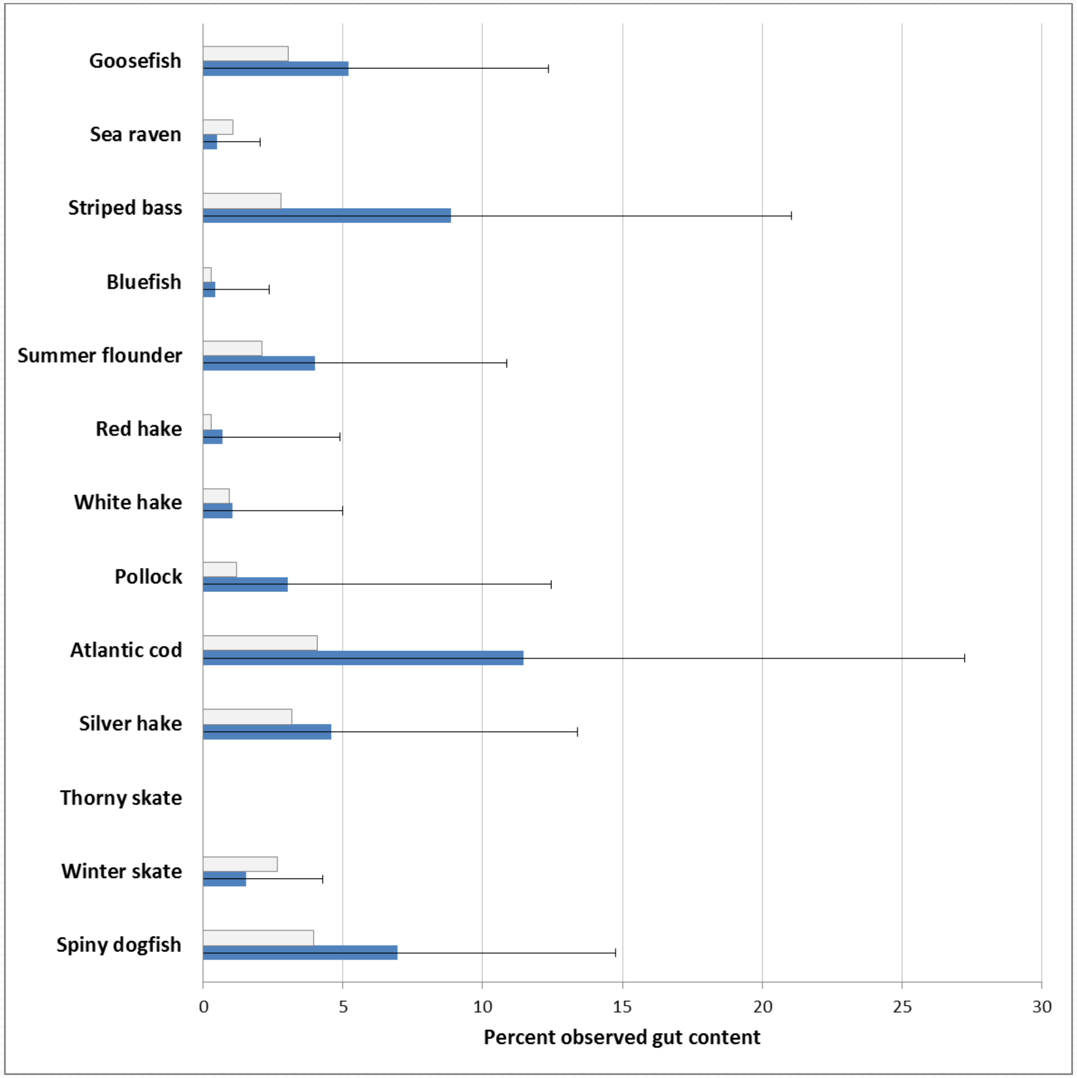
Beneficiaries	Mechanism	Magnitude
Fish predators (e.g. cod, dogfish, silver hake)	Faster growth, higher condition factor, more energy available for reproduction.	Unknown
Tuna	Same as above plus larger patches of herring as an attractant (availability)	Important
Whales	Same as above plus larger patches of herring as an attractant (availability)	Possibly important (alternative preys?)
Seabirds	Same as fish	Possibly important, for specific species

Herring predators,1973-2010 spring

(% of gut contents; Table A6-10 from SAW 54)

- Average percent in blue with one standard deviation around the mean

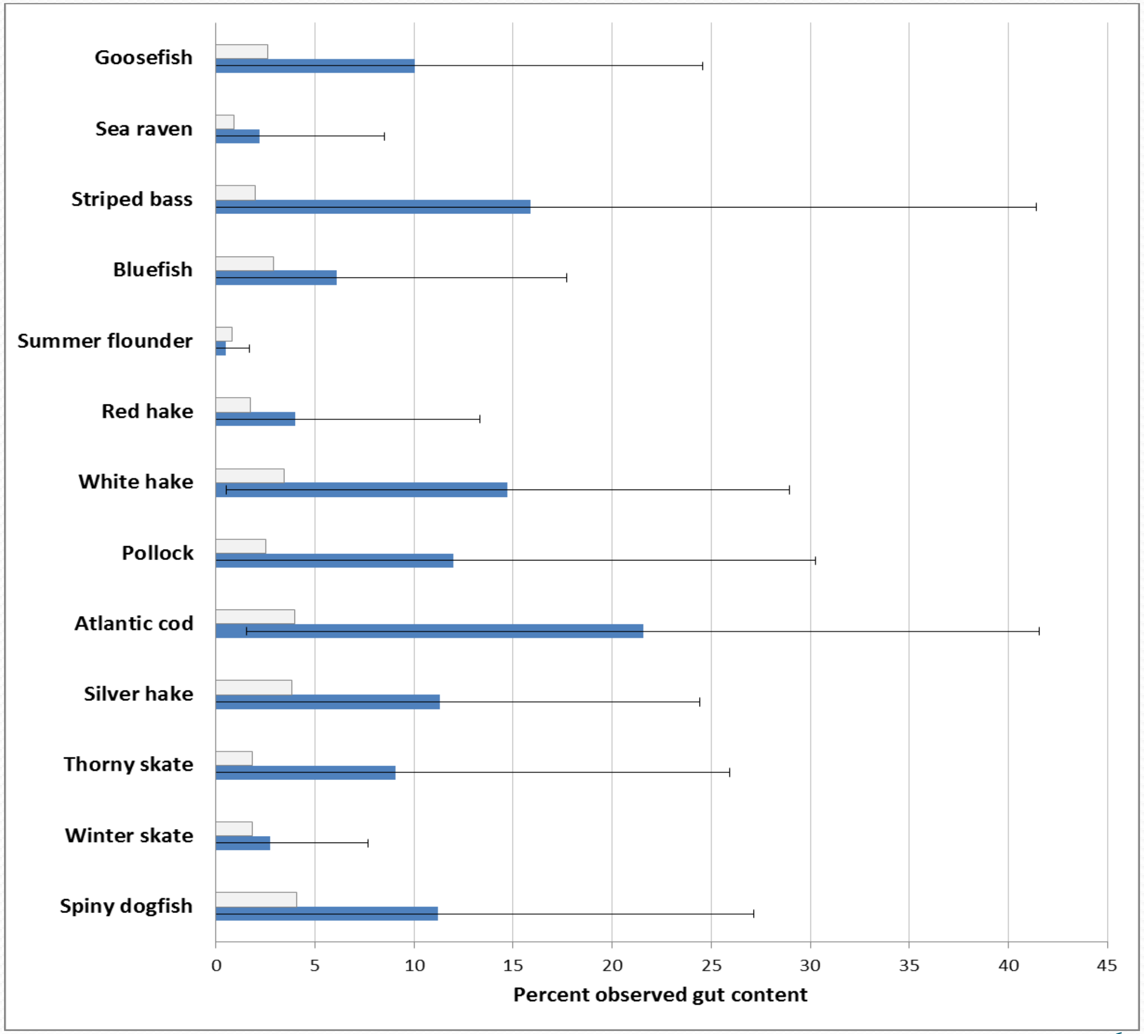
- Plotted with grey shading, persistence is the percent of years with herring in the observed guts



Herring predators,1973-2010 fall

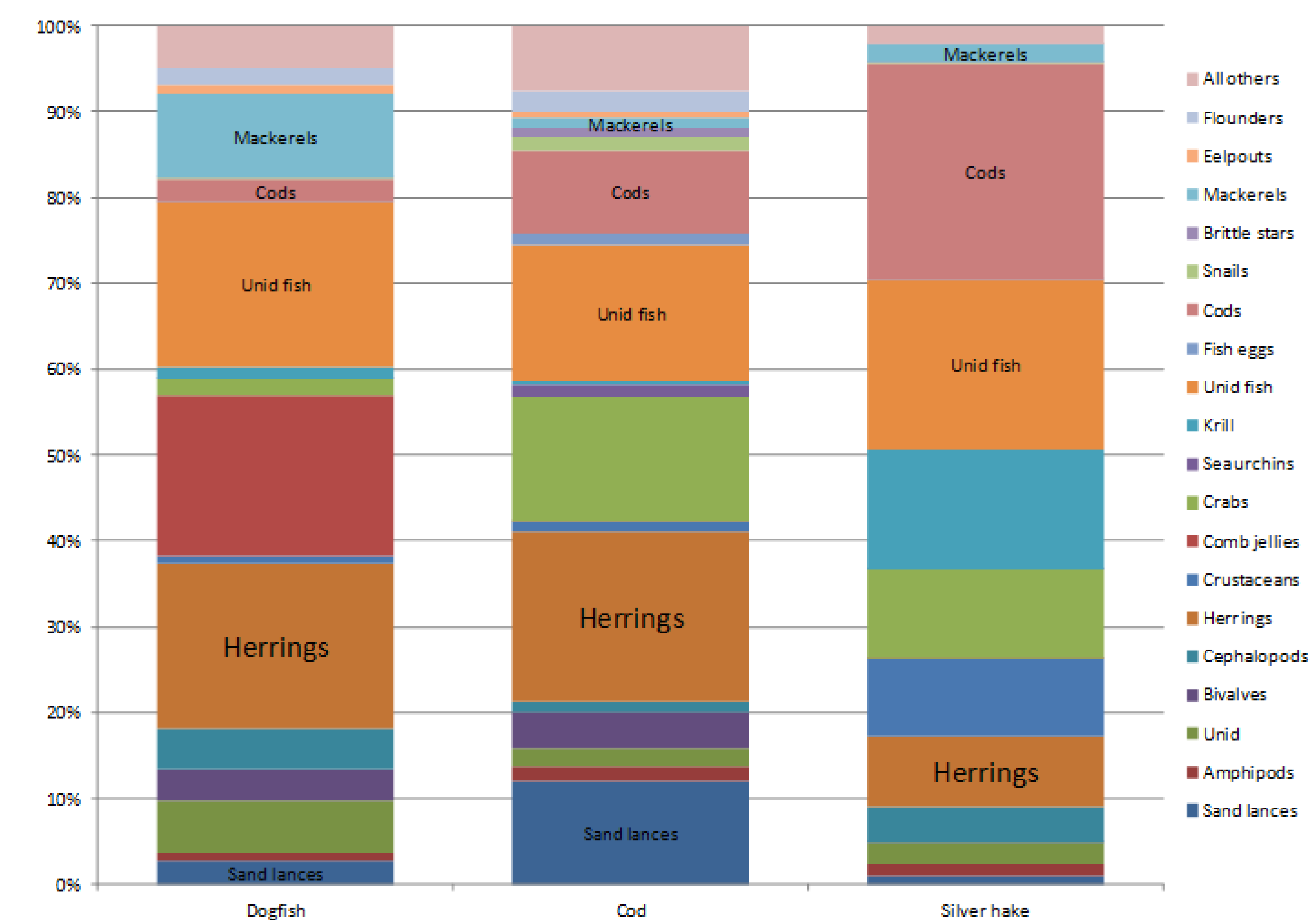
(% of gut contents; Table A6-9 from SAW 54)

- Average percent in blue with one standard deviation around the mean
- Plotted with grey shading, persistence is the percent of years with herring in the observed guts



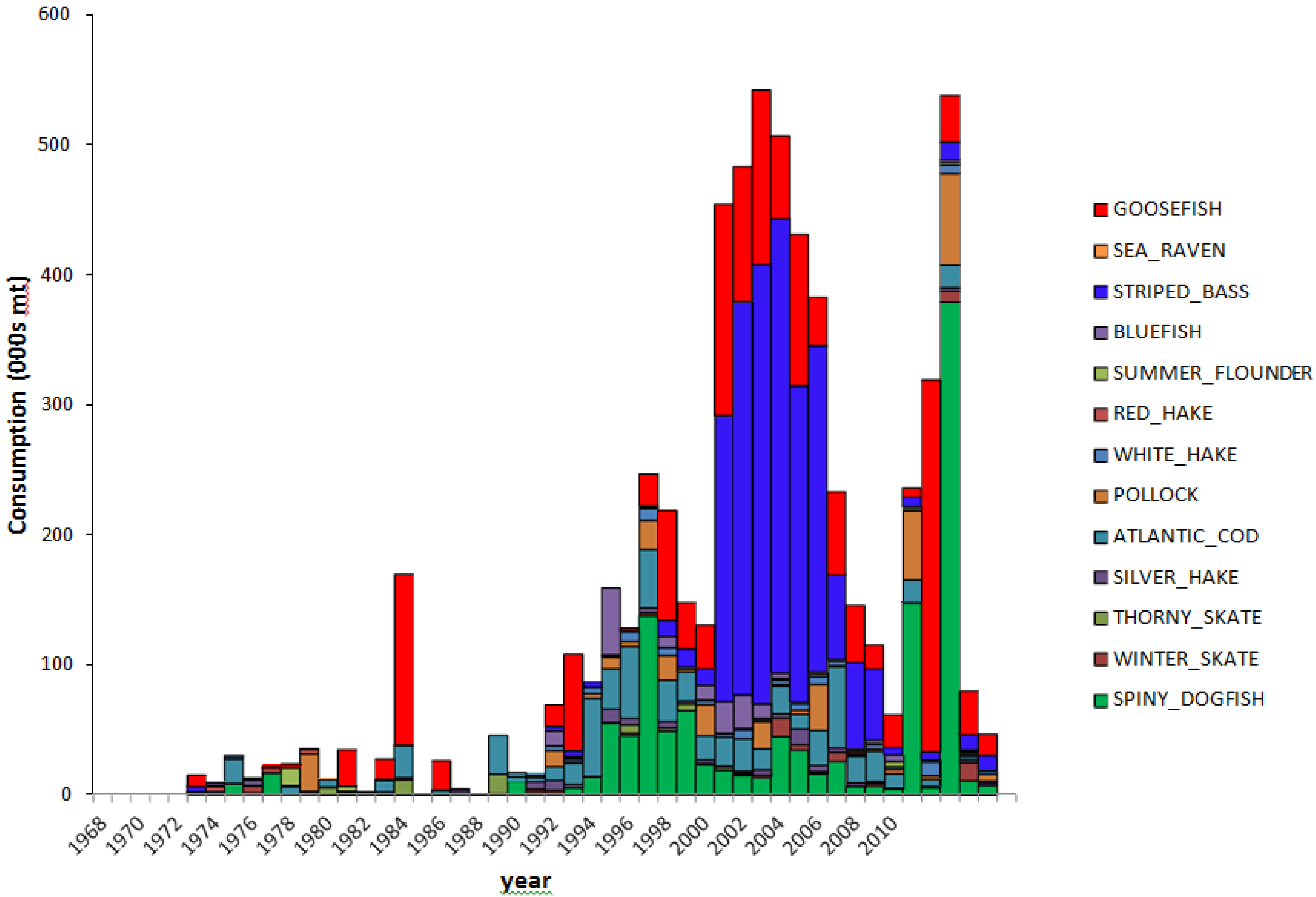
Estimated diet for three top fish predators, 1973-2012

- Gulf of Maine, Georges Bank, Southern New England combined

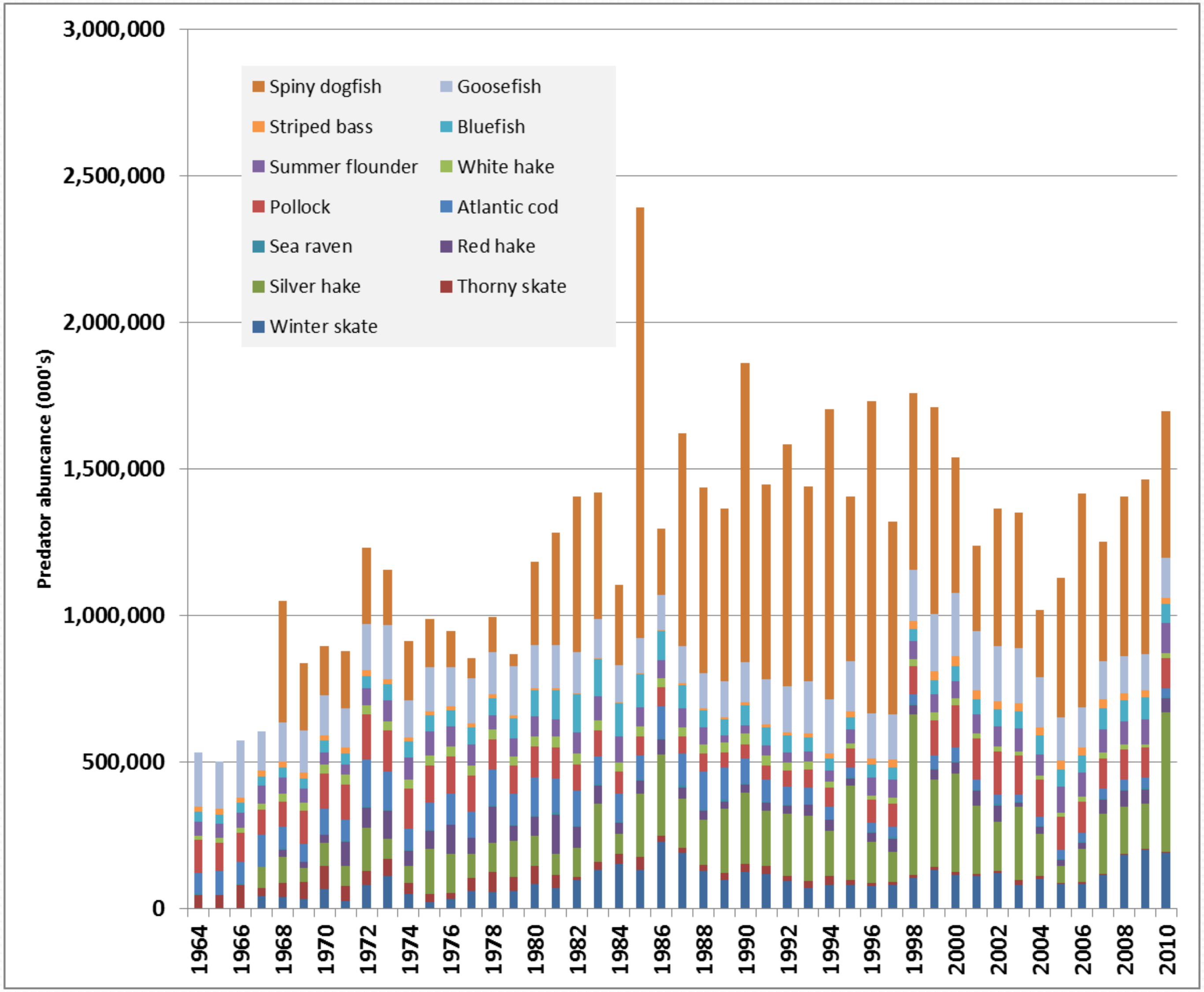


Herring consumption by fish

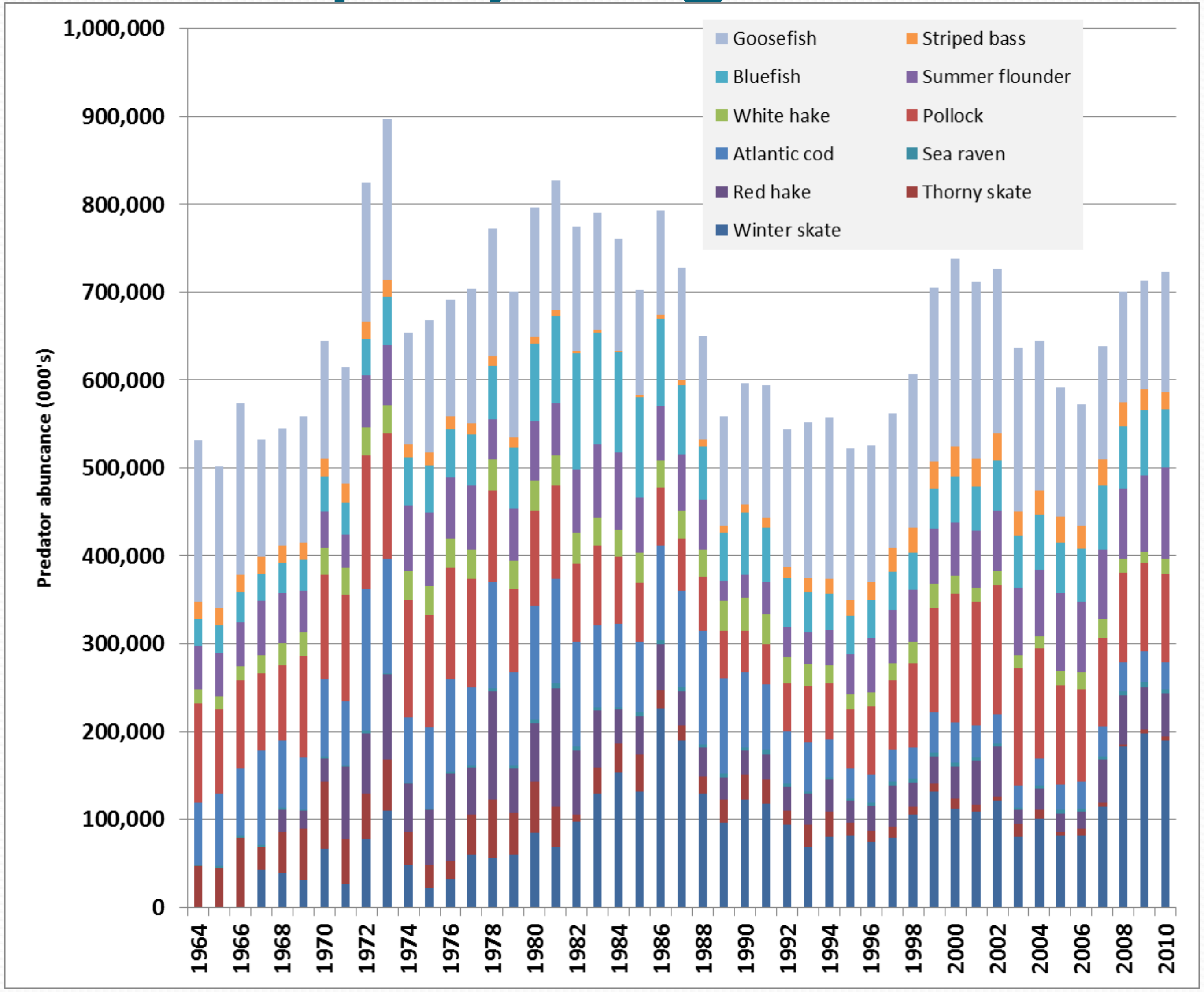
Saw 59, Figure A6-5



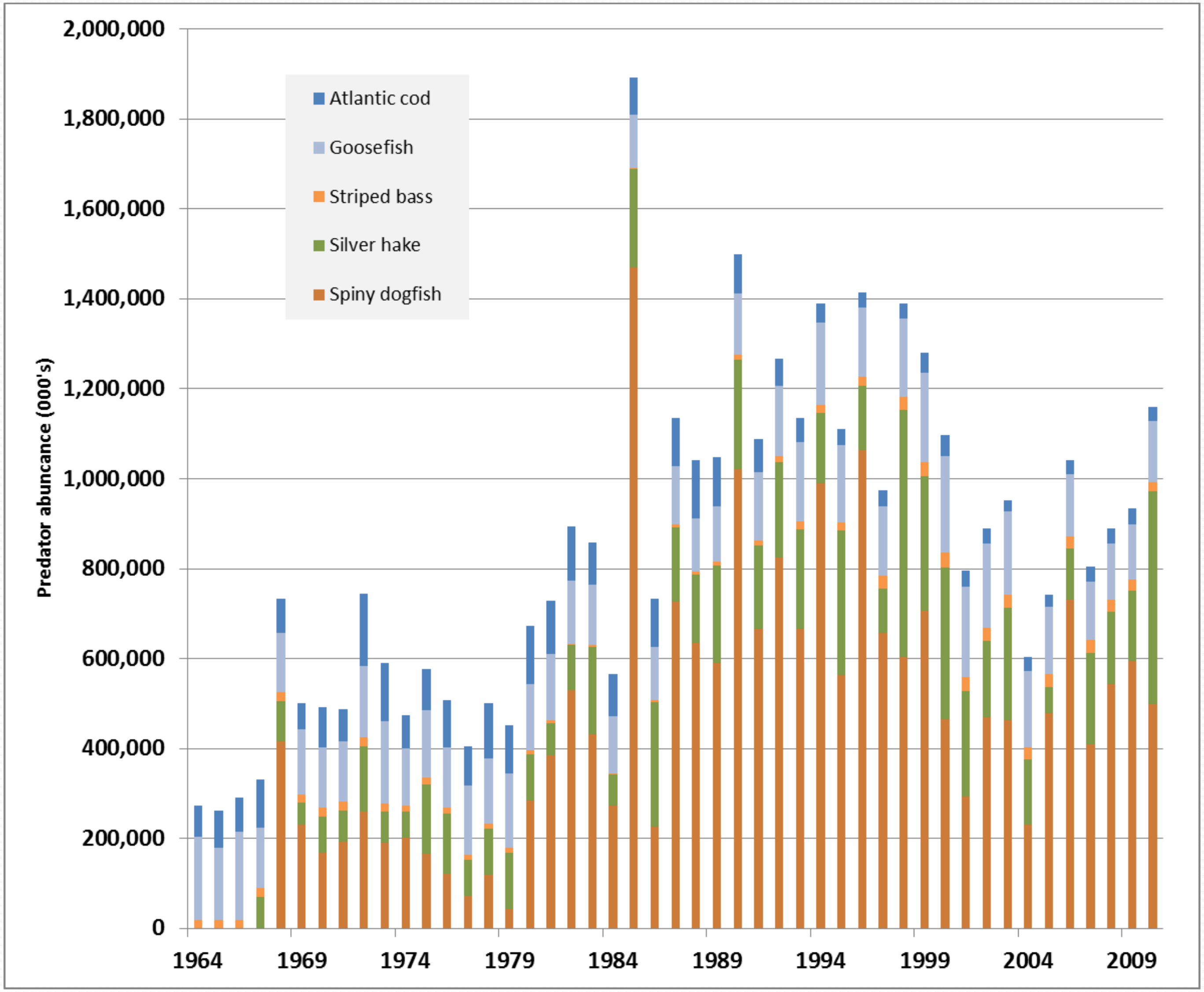
Fish predator abundance



Fish predator abuncance without spiny dogfish

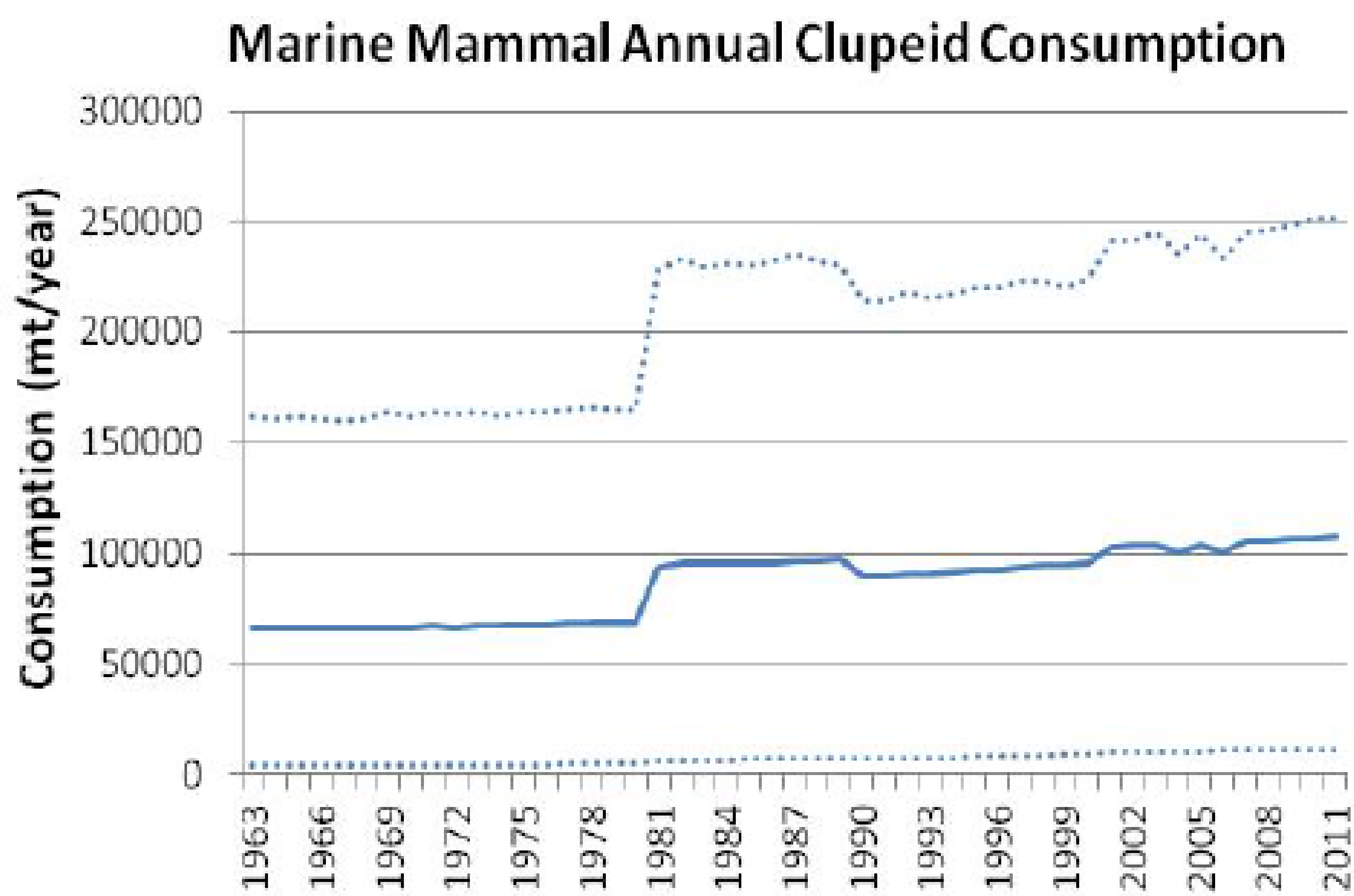


High reliance predators

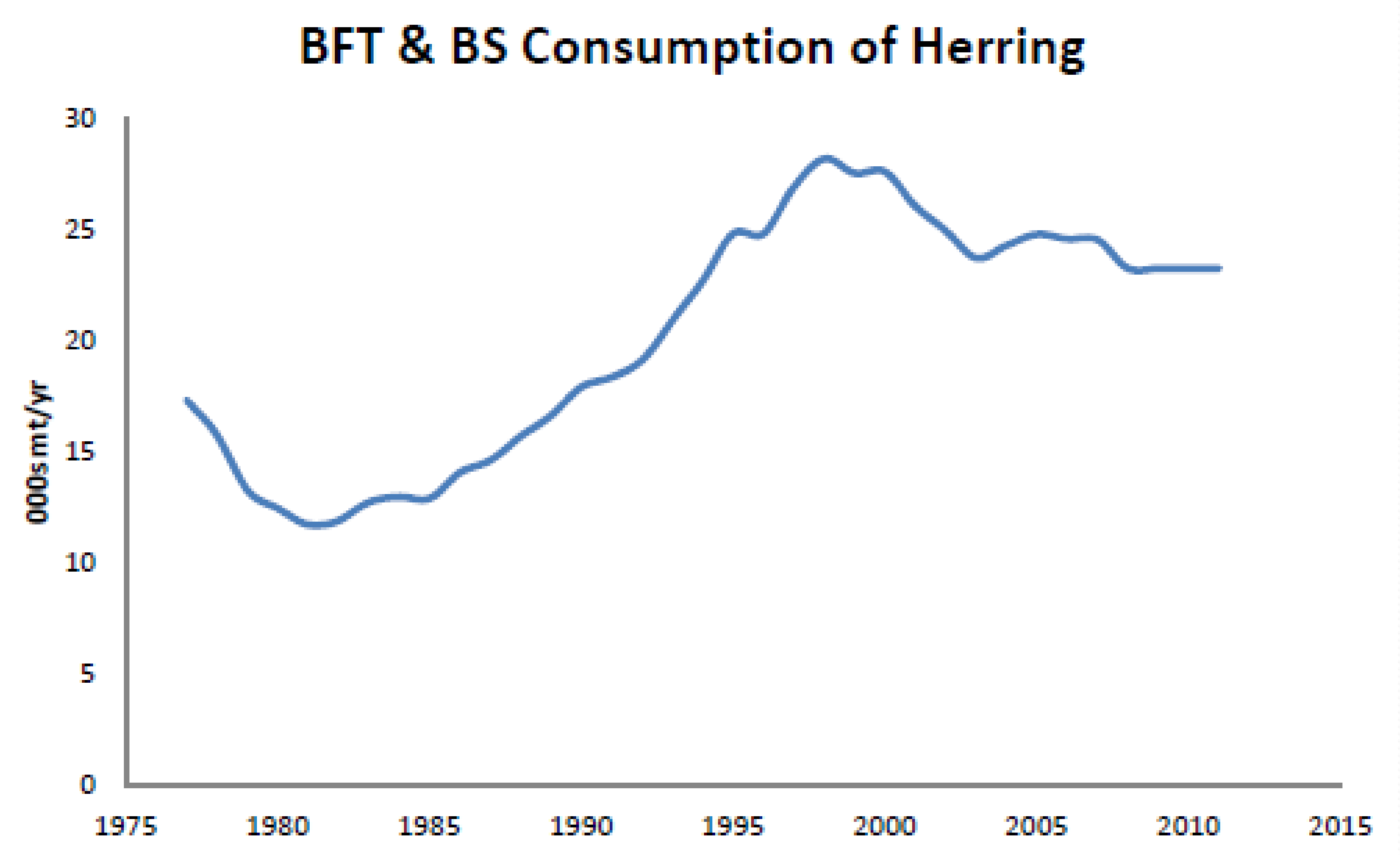


Clupeid consumption by marine mammals

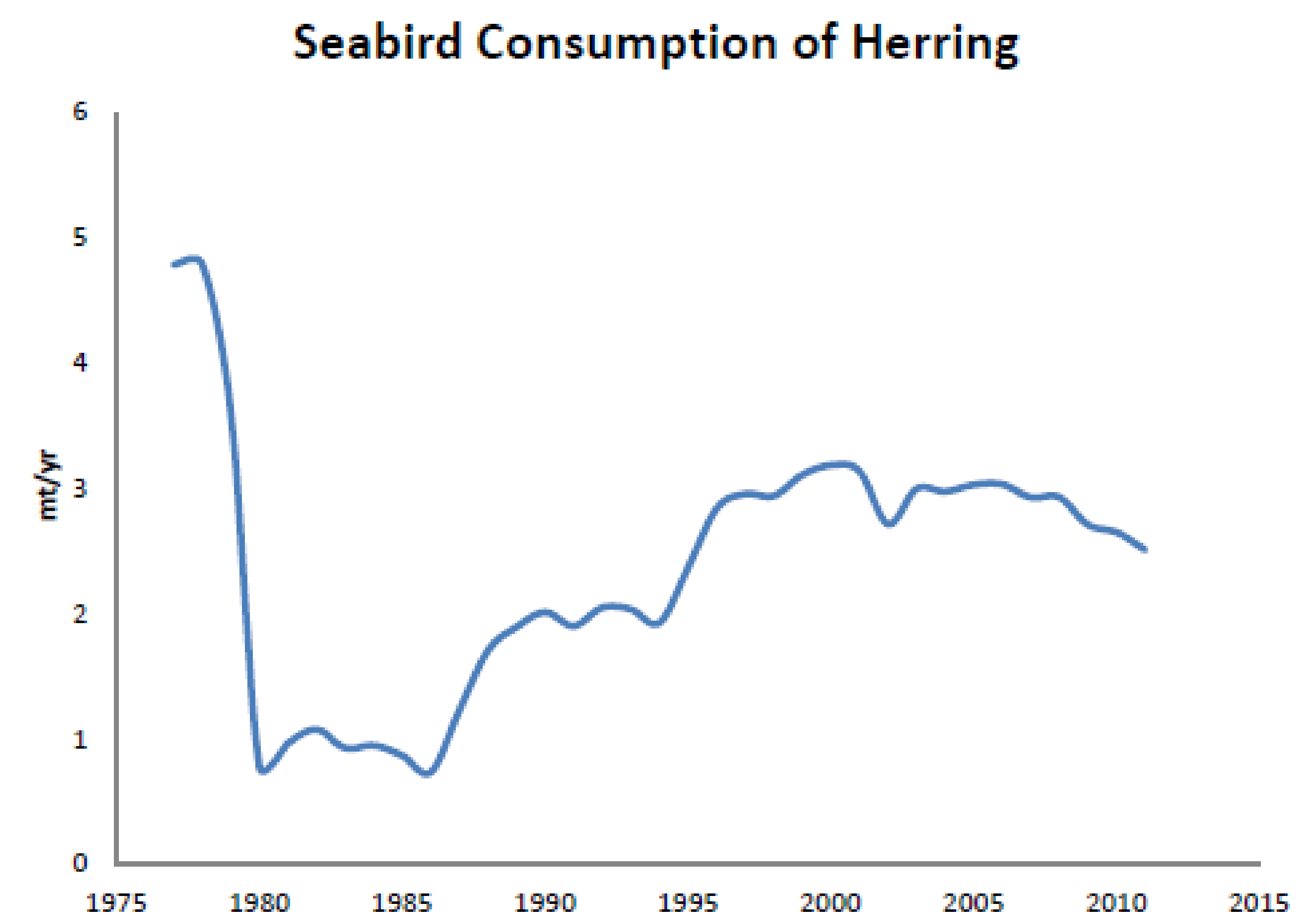
Saw 54, Figure A6-6



Herring consumption by bluefin tuna and blue sharks; Saw 54, Figure A6-7



Herring consumption by seabirds; Saw 54, Figure A6-8

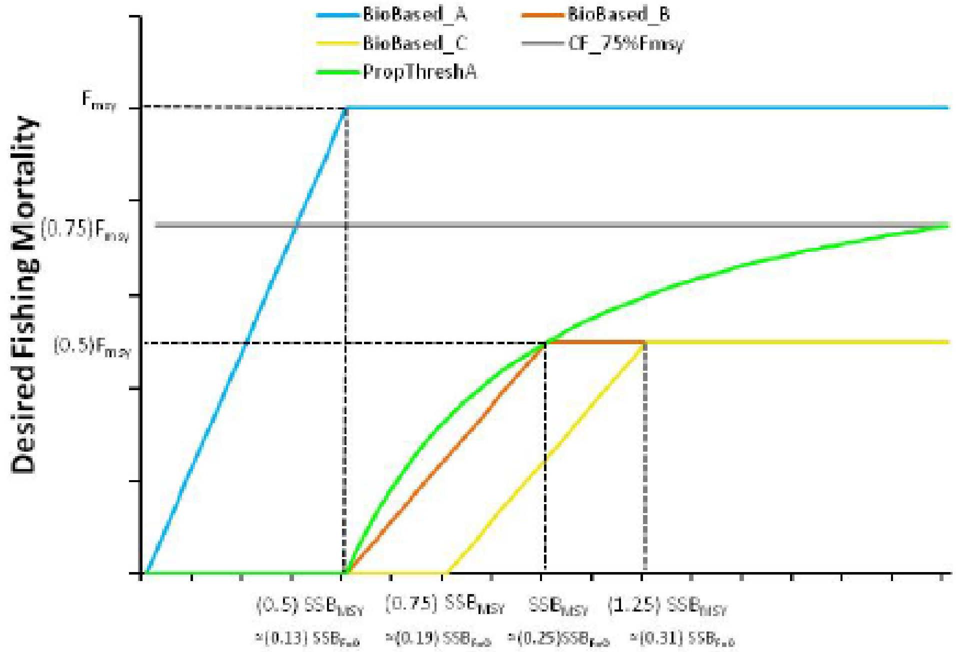


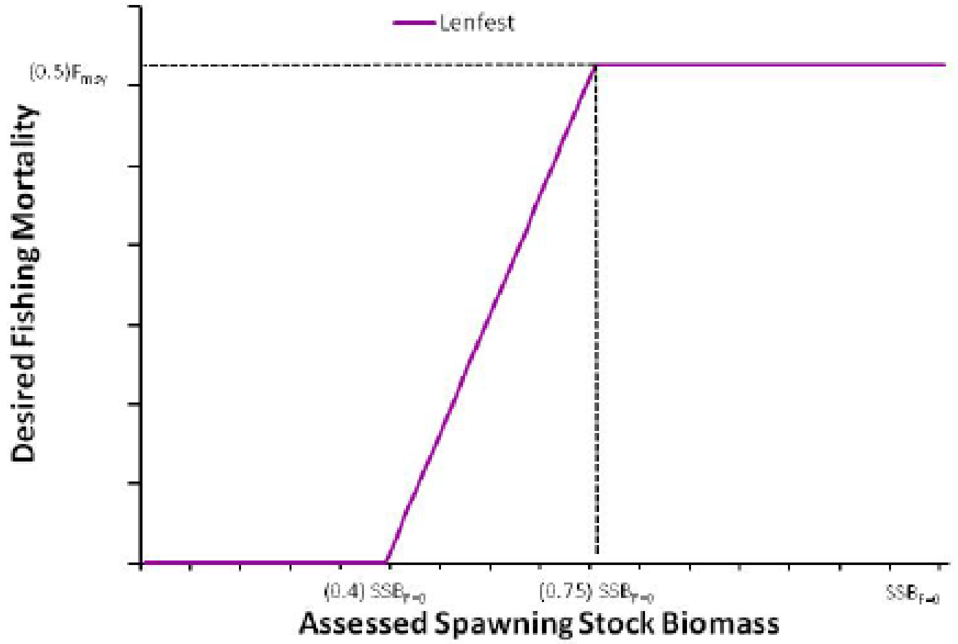
Atlantic herring status

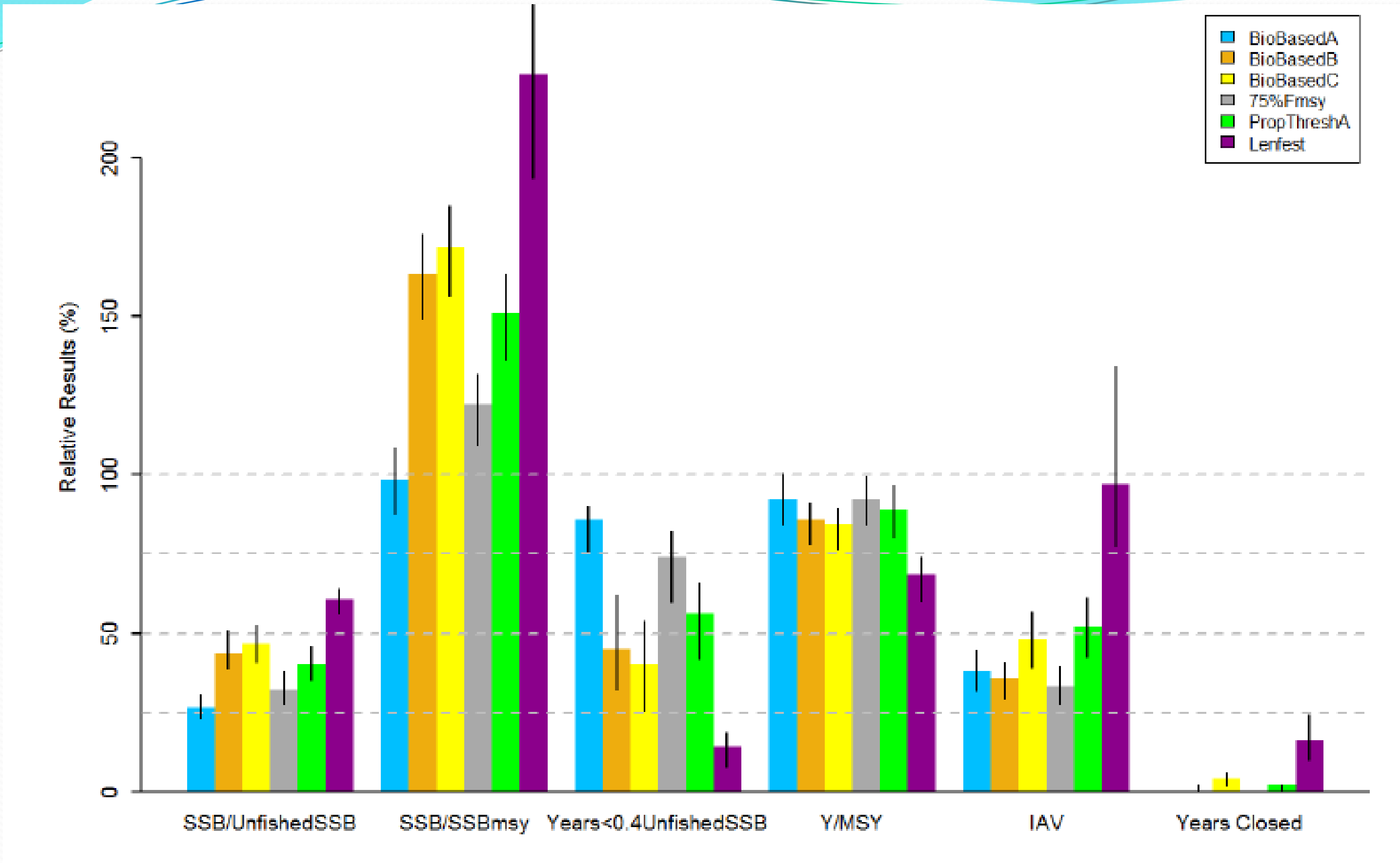
- Not overfished; Overfishing not occurring
- Constant catch ~100,000 mt
- Unfished SSB est = 845,176 mt
- Retrospective-adjusted 2014 SSB = 622,997 mt (74%)

Control rule performance

- Six scenarios compared:
  - Status quo (F_{msy};0.5 SSB_{msy} threshold)
  - Constant F (F=0.75 F_{msy})
  - Biomass based B (0.5 F_{msy}; SSB_{msy} threshold ~ 0.25 SSB_o)
  - Biomass based C (0.5 F_{msy}; 1.25 SSB_{msy} threshold ~ 0.31 SSB_o)
  - Proportional escapement (F_{msy}-> SSB_o)
  - Lenfest (0.5 F_{msy}; 0.75 SSB_o threshold)


BioBased_A
BioBased_B
BioBased_C
CF_75%Fmsy
PropThreshA
Fmsy
(0.75)Fmsy
(0.5)Fmsy
Desired Fishing Mortality
(0.5) SSBMSY
(0.75) SSBMSY
SSBMSY
(1.25) SSBMSY
≈(0.13) SSBF=0
≈(0.19) SSBF=0
≈(0.25)SSBF=0
≈(0.31) SSBF=0


Lenfest
(0.5)Fmsy
Desired Fishing Mortality
(0.4) SSBF=0
(0.75) SSBF=0
SSBF=0
Assessed Spawning Stock Biomass


BioBasedA
BioBasedB
BioBasedC
75%Fmsy
PropThreshA
Lenfest
Relative Results (%)
0
50
100
150
200
SSB/UnfishedSSB
SSB/SSBmsy
Years<0.4UnfishedSSB
Y/MSY
IAV
Years Closed

Comparative results

Tradeoffs in average biomass, yield, and risk of closure

- Biomass
  - Lenfest (only one to exceed 50% SSB_0)
  - Biobased B & C
  - Proportional escapement
  - Constant F
  - Status quo (25-30% SSB_0)

Control rule simulations

- High M phase (time-varying) partly due to trends in consumption.
- Control rule simulations used fixed steepness parameter, estimated uncertainty applied
- Steepness parameter associated with high M/higher consumption phase

Control rule simulations

- Majority of consumption by fish are pre-recruits
- Predation affects steepness parameter
- Appropriate buffer for ecosystem needs if steepness parameter accounts for predation?

Trophodynamic models

- Incomplete, untested, need parameterization
- Many apply to portion of herring stock area
- Most would take a year or more of dedicated work to apply to assess herring control rules
- Others do not apply specifically to herring
- Some do not incorporate prey abundance feedback to predator productivity

Trophodynamic models

- Kraken (Gamble and Link 2009; Gamble et al in prep)
  - Georges Bank only
  - Parameter estimation and performance testing underway
  - Simulations run, but estimation mode being developed
- Atlantis (Link et al 2010, 2011)
  - End-to-tend spatial ecosystem model
  - Incorporation of control rule performance needs integration
  - Model being updated to version 1.5

Trophodynamic models

- Dynamic Food Web (Lucey et al. in prep)
  - Implementation of Ecopath/Ecosym
  - Initiated for Georges Bank only
  - Incorporates estimated uncertainty in food web parameters
- Multispecies Statistical Catch at Age (Curti et al 2013)
  - Three species; 9 species extension planned
  - No prey feedback

Trophodynamic models

- Hydra (Gaichas et al in prep; based on Hall et al 2006)
  - Multispecies size structured model
  - Georges Bank only
  - No prey feedback
- EMAX Food Web (Link et al. 2006, 2008a; 2008b)
  - Guild model
  - Includes prey feedback loop

Trophodynamic models

- MSVPA-X (Tyrell et al. 2008; Garrison et al. 2010)
  - No prey feedback loop
- MS-PROD (Gamble and Link 2009; Gaichas et al. 2012)
  - Strategic simulations
  - No prey feedback loop

Ecosystem model status

- Although model development efforts are pretty far along, useful models to evaluate effects of herring control rules on the ecosystem are 2-5 years away
- Model verification, testing, and peer review
- More time to develop Amendment 8 control rule options would allow time to develop a more general forage management policy

Climate change

- Has the distribution of major herring predators changed relative to herring distribution (temperature, depth, latitude)?
- Changes in thermocline development and migratory behavior?
  - Patchiness and availability
  - Survey catchability
- Changes in physiology and growth
- Changes in ecosystem communities and novel communities

Ecosystem conclusions

- Models
  - Abandon concept of MSY and other types of single species reference points
  - Reference points more dynamic and account for trophic interactions
  - More comprehensive and accurate advice; account for uncertainty
- Difficult to predict whether any specific species will benefit from greater prey availability
  - Interactions and indirect effects
  - Density-dependent effects on herring condition factor and energy content (e.g. Golet et al
  - Dynamics sorted out with full food web models; subsets can give misleading results

Lenfest report – Little fish, Big impact – April 2012

- Examined Ecosym-modeled effects for 10 systems
- Predator response to the exploitation of prey (PREP equation)
- Introduced an unknown amount of stochasticity (constant across ecosystems?) to assess risk.
- Recommended general policy for forage fish management, e.g. hockey stick control rule with high B target and 50-75% $F_{msy} = F_{lim}$
- May not be applicable to Georges Bank or NW Atlantic ecosystem
- PREP equation parameters have not been estimated here

Lenfest report – Little fish, Big impact - 2012

TABLE 6.1

Ecosystems and their forage fish species

The forage fish species and species groups analyzed in our research, along with their respective ecosystems and the EwE models' authors.

Ecosystem	Forage fish species or group (as developed by modeler)	Model authors and reference
Aleutian Islands	• herring (*Clupea pallasii pallasii*) • sand lance (*Ammodytes hexapterus*) • small pelagics (*Mallotus villosus, Engraulis mordax, Scomber japonicus*, Osmeridae)	*Guénette et al. (2006)*
Baltic Sea	• herring (*Clupea harengus*) • sprat (*Sprattus sprattus*)	*Hansson et al. (2007)*
Barents Sea	• capelin (*Mallotus villosus*) • herring (*Clupea harengus*) • pelagic planktivorous fish (*Ammodytidae, Trisopterus esmarkii, Micromesistius poutassou, Argentine* spp.*, Cyclopterus lumpus, Sprattus sprattus*, Osmeridae, Clupeidae)	*Blanchard et al. (2002)*
Chesapeake Bay	• alewives & herring (*Alosa pseudoharengus* and *A. aestivalis*) • American shad (*Alosa sapidissima* and *A. mediocris*) • Atlantic menhaden (*Brevoortia tyrannus*)	*Christensen et al. (2009)*
Gulf of Mexico	• bay anchovy (*Anchoa mitchilli*) • Gulf menhaden (*Brevoortia patronus*) • scaled sardine (*Harengula jaguana*) • threadfin herring (*Dorosoma petenense*)	*Walters et al. (2006)*
Humboldt Current	• Peruvian anchoveta (*Engraulis ringens*) • sardine (*Sardinops sagax*)	*Taylor et al. (2008)*
Northern California Current	• euphausiids (order Euphausiacea) • forage fish (*Engraulis mordax, Clupea harengus pallasi, Thaleichthys pacificus, Allosmerus elongates*) • sardine (*Sardinops sagax caerulea*)	*Field et al. (2006)*
North Sea	• herring (*Clupea harengus*) • sand eel (*Ammodytes* spp.) • sprat (*Sprattus sprattus*)	*Mackinson and Daskalov (2007)*
Southeast Alaska	• herring (*Clupea harengus*) • sand lance (*Ammodytes hexapterus*) • small pelagics (*Mallotus villosus, Engraulis mordax, Scomber japonicus*, Osmeridae)	*Guénette et al. (2006)*
Western English Channel	• herring (*Clupea harengus*) • pilchard (*Sardina pilchardus*) • sand eel (*Ammodytes tobianus*) • sprat (*Sprattus sprattus*)	*Araujo et al. (2005)*

Ecosystem conclusions

- Lenfest forage management approach
  - Much more conservative than MSY-based control rule (threshold at 75% Bo, rather than 25% Bo)
  - Risk adverse approach for systems lacking good information about dynamics
  - Focus on upwelling systems – fewer stocks; strong trophic links
- Gulf of Maine, Georges Bank, and Southern New England/Mid-Atlantic ecosystem
  - Complex
  - Not upwelling
  - Many top predators are generalists

Ecosystem conclusions

- Spatial and availability concerns
  - Control rule based on something other than total biomass
    - School size
    - School density
    - Spatial allocation based on localized indicators

2014 Annual Atlantic Herring Specifications (January 1-December 31)

Stock	Atlantic Herring
Overfishing Limit (OFL)	136,000 mt
Acceptable Biological Catch (ABC)	114,000 mt
Annual Catch Limit (ACL)	107,800 mt
Domestic Annual Harvest	107,800 mt
Border Transfer	4,000 mt
Domestic Annual Processing	103,800 mt
U.S. At-Sea Processing	0 mt
Optimal Yield (OY)	107,800 mt

Border Transfer: 4,000 mt of Atlantic herring has been allocated for the use of border transfer between U.S. commercial fishing vessels and Canadian herring transport vessels.

Research Set Aside: Up to 3-percent of the stock-wide herring ACL can be set-aside for use in research.

2014 Atlantic Herring Research Set-Aside	
Area 1A	936 mt
Area 1B	138 mt
Area 2	900 mt
Area 3	1,260 mt

Final Commercial Quota:

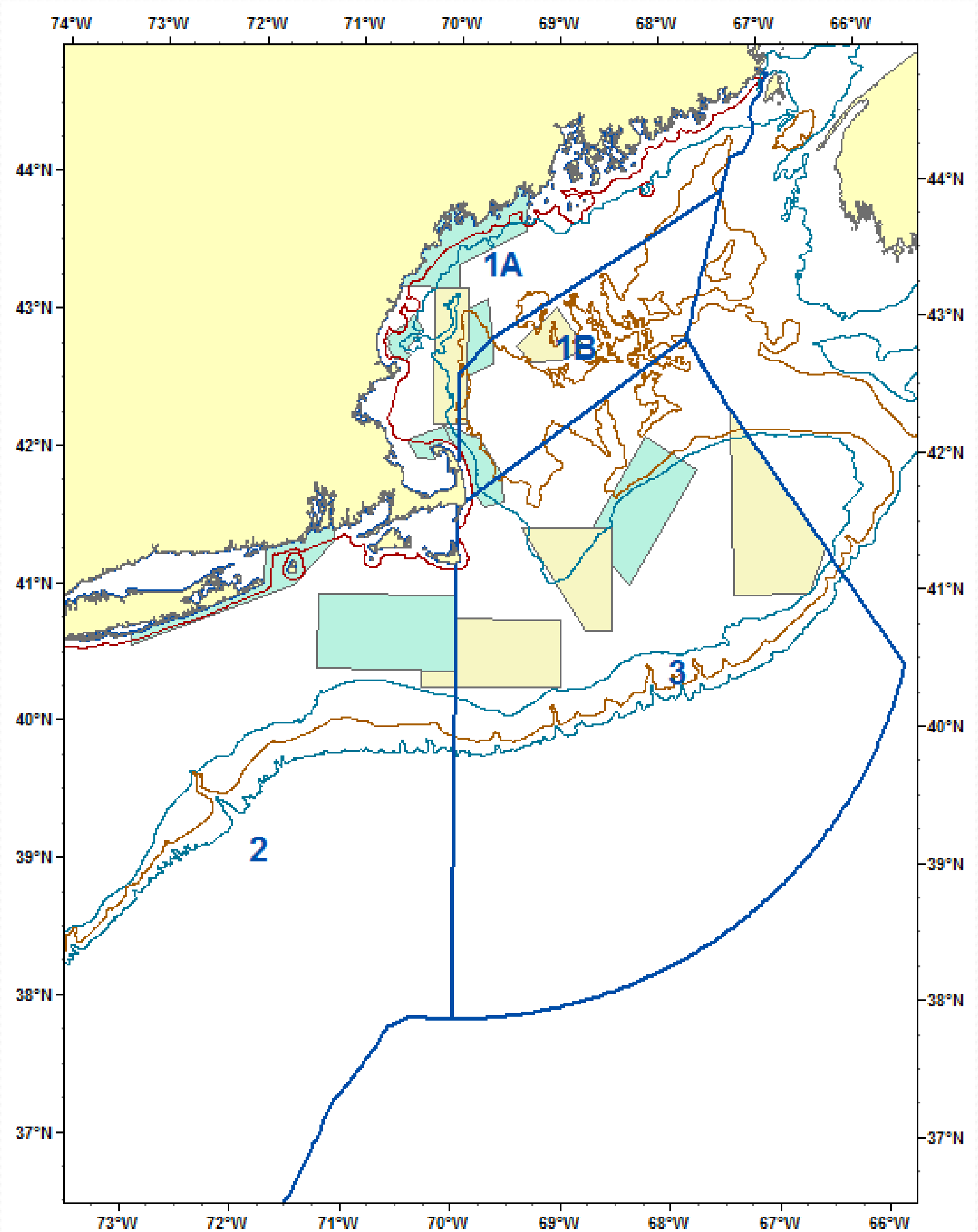
2014 Area Sub-ACLs*	
Area 1A†	33,031 mt
Area 1B††	2,878 mt
Area 2	28,764 mt
Area 3	39,415 mt

* Area sub-ACLs include overage deductions and carryover from 2012, and exclude research set-aside mt.

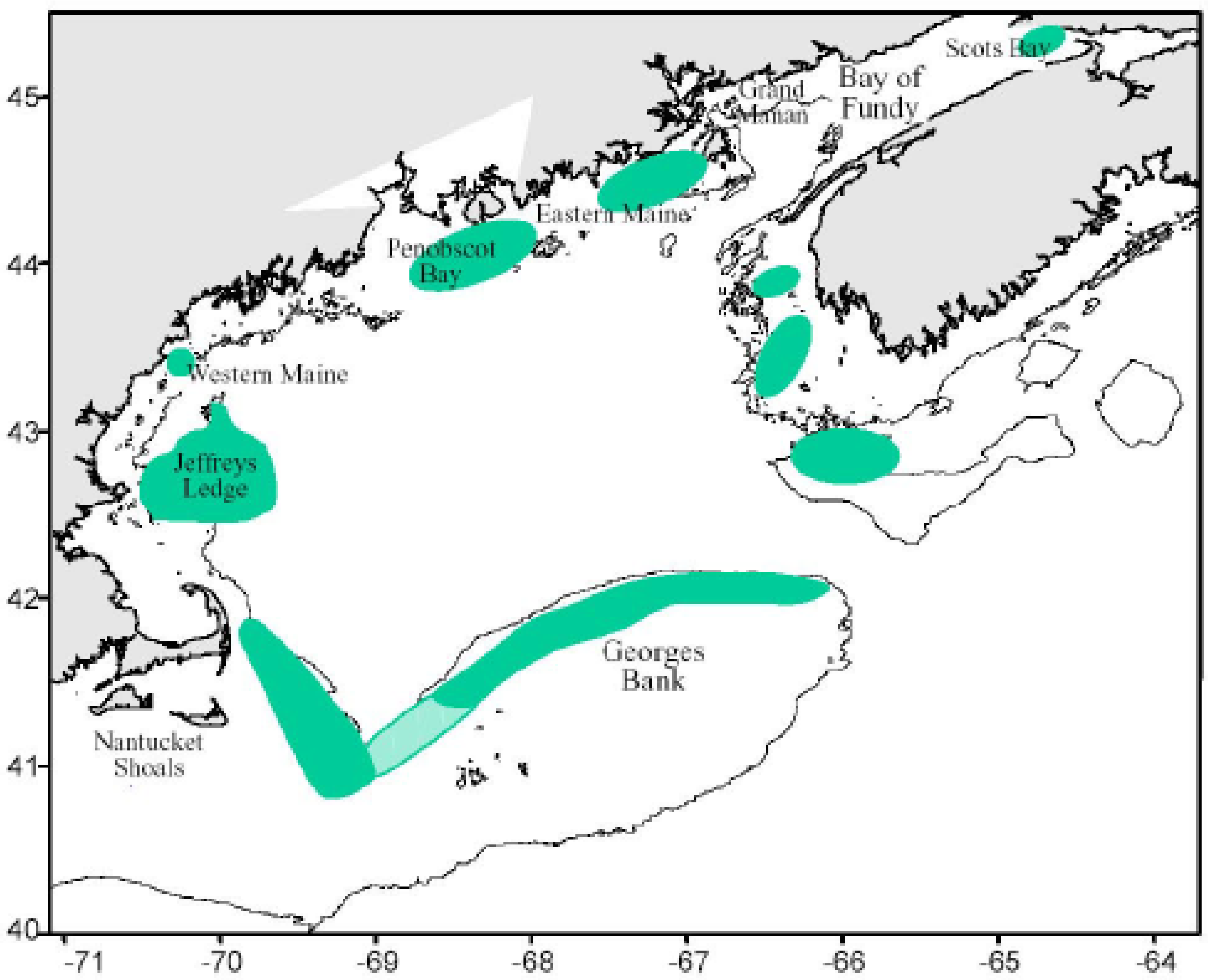
†Area 1A Sub-ACL: The Area 1A sub-ACL is divided into two seasons: January 1 - May 31 and June 1 - December 31. Vessels may not fish for, possess, or retain herring from January 1 through May 31 in Area 1A.

††Area 1B Sub-ACL: The Area 1B sub-ACL is divided into two seasons: January 1 - April 30, and May 1 - December 31. Vessels may not fish for, possess, or retain herring from January 1 through April 30 in Area 1B.

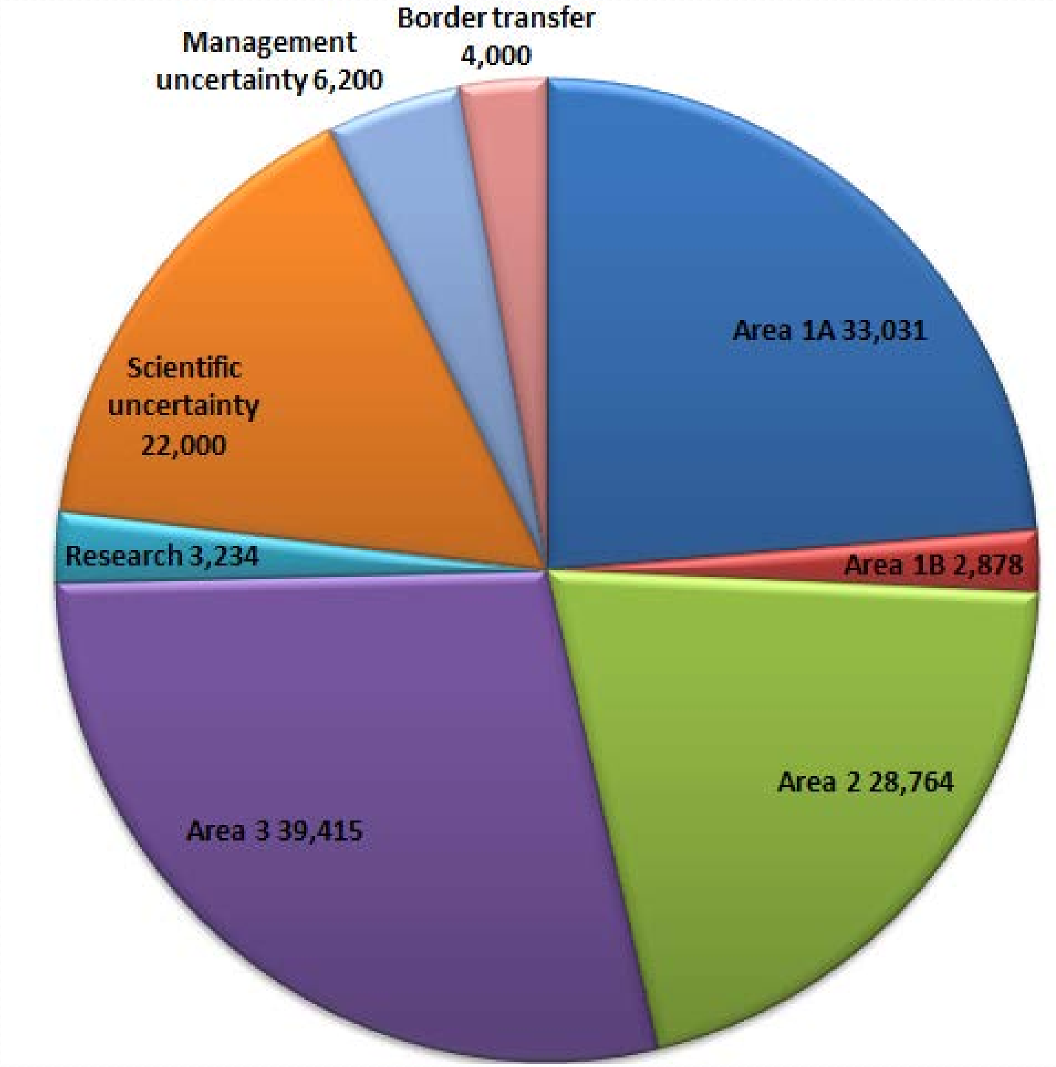
Herring management areas



Generalized major herring spawning areas (from Overholtz 2014)



ABC allocation



Considerations

- Most predatory fish in the NE Ecosystem are generalists; prey on young herring and pre-recruits
- Tunas and marine mammals that rely on a herring diet
- Atlantic herring biomass is well above SSB_{msy} (74% SSB_o)and is likely to remain well above SSB_{msy} (or higher thresholds) for some time with current ABCs.
- Abundance of alternative forage species is an important consideration

Considerations

- Time is needed to parameterize, validate, and conduct peer review of ecosystem models applied to NE and evaluate the effects of various herring control rules on our ecosystem
- Forage white paper being developed and may become the basis for forage species management in a fishery ecosystem plan.

Considerations

- Local availability may be more import to some species and industries than total stock size
- Local availability cannot be addressed with a stock-wide control rule, but localized harvests can be managed with sub-ACLs and season/area fishing restrictions, which currently exist and could be modified.